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ABSTRACT

This report presents a description of a process for instructional system design, identification of the steps in the design process, and determination of their sequence and interrelationships. As currently envisioned, several interrelated steps must be taken, five of which provide the inputs to the final design process. There are analysis of learner population, statement of general policy, lesson analysis, specification of strategies of instruction, and specification of design criteria. The final design process generates a description of the instructional system in terms of its time-dependent requirements for resources: personnel, facilities, materials, and equipment. The last step is a cost analysis to determine the dollar requirements for the system. These outputs will assist the educational planner in implementing new methods of instruction. (Author)

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DEVELOPING A METHODOLOGY FOR DESIGNING SYSTEMS OF INSTRUCTION

Polly Carpenter

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THE PROBLEM

Many new ways of teaching and much instructional technology have been developed and validated for their contributions to effective instruction, yet these innovations have seen but little implementation in existing teaching institutions. One of the prime reasons for this is that the designers of instruction, even when they are not also burdened with the task of classroom teaching, are not sufficiently familiar with the new systems to plan their implementation or must rely for planning and design on their intuition and judgment. These are shaped largely by their familiarity with existing facilities, equipment, operating practices, and materials, and by available personnel. Innovations in the process of instruction at a teaching institution arise primarily from the efforts of a few people who believe that some particular strategy of instruction or application of new instructional technology will be more effective than methods already in use. If such people succeed in convincing school personnel of the merits of their position, they must either go through a lengthy design process with very little to assist them besides their own convictions, or they must effect the change through trial and error. Inevitably they cannot have had first-hand experience with a variety of alternatives. More effective or less expensive instruction may result, but there is no assurance that it is as effective as it could be, no assurance that other strategies could not be used along with the one of primary interest to improve efficiency, no assurance that more desirable combinations of techniques, operating procedures, materials, and equipment have not been overlooked.

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No single designer or design team can have had enough first-hand experience to know all possible alternatives or to choose wisely among them. The objective of the Rand research is to correct this situation, at least in part, by developing methodologies for the design of systems for instruction. These design methodologies will assure that promising alternatives are not overlooked, thereby pointing the way to improved instructional systems in a wide range of situations.

THE APPROACH

This paper describes some Rand work* directed toward improving the effectiveness of instruction, whether it be in the classroom, shop, or laboratory or in the field, by facilitating the implementation of innovations in actual school situations. The work focuses on the development of methodologies for planning and designing systems for teaching a course defined in terms of a set of learning objectives. These methodologies will provide planners with tools that will both make it easier for them to design new instructional systems and will help assure that their designs are comprehensive, coherent, and appropriate to their needs. The process could take a matter of a few weeks or perhaps even a few days, rather than taking, say, several months to a year as it does at present. This will allow planners to consider several possible alternative ways to conduct a particular course so that they may choose the way that is most promising.

In short, we are working out a process for instructional system design. This process has certain inputs and outputs. A description of the outputs will illustrate the direction of our efforts in specific terms. The outputs are the following characteristics of an instructional system: course length; student flow, as a function of time during the course; and the time-dependent requirements for resources, such as facilities, material, instructors, and support personnel. (See Fig. 1.) These outputs will be related to the inputs, which we characterize

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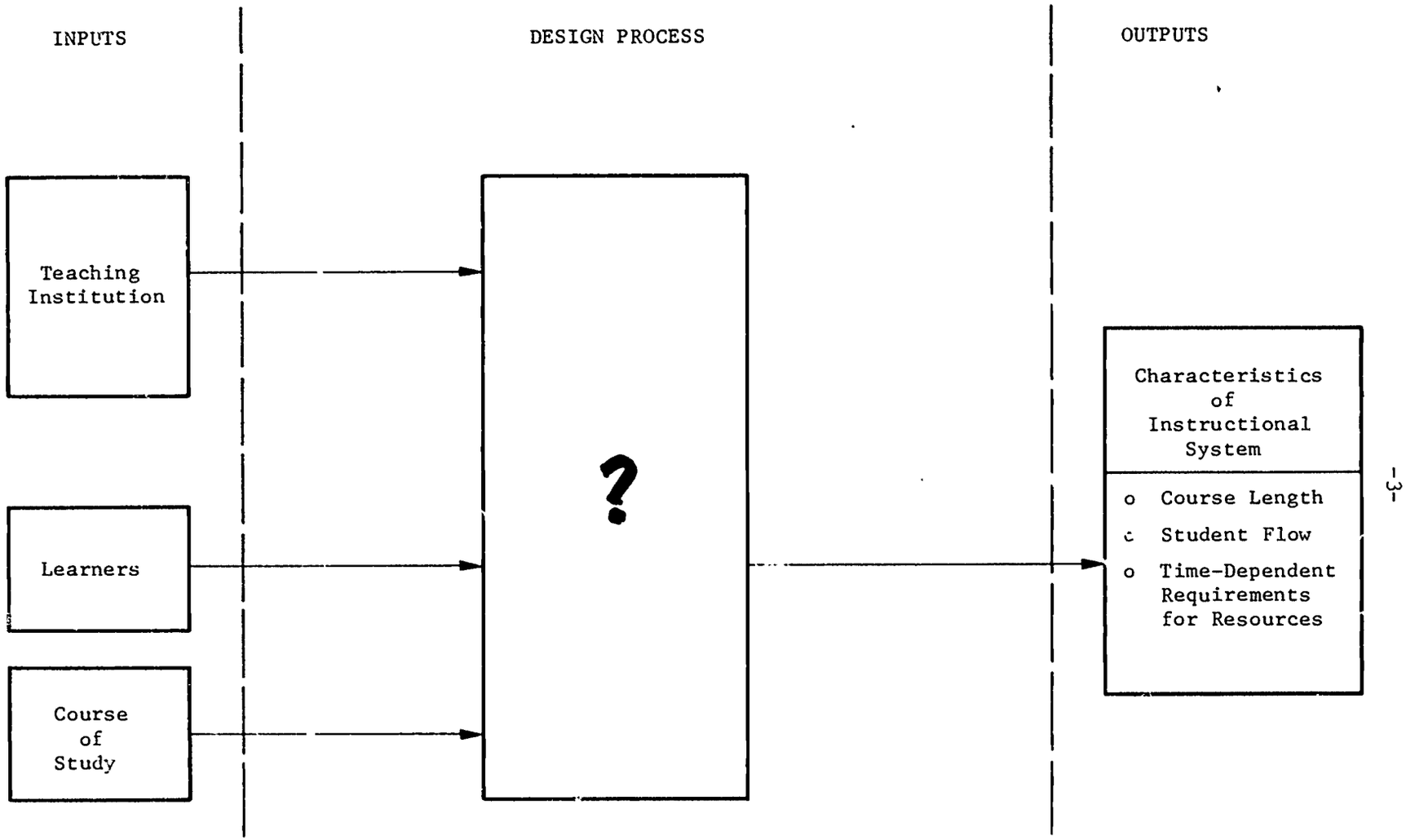

Fig. 1--Framework of the Design Process

in three general areas: the teaching institution; learners for whom the course of study is intended; and the course objectives.

The design process relates outputs to inputs so that the outputs will be acceptable to the teaching institution, and the instructional system they describe will teach the course of study to the designated learners. We are now in the process of identifying the steps in the design process, determining their sequence, and discovering their interrelationships. This has never before been done in a systematic way, to our knowledge; it is a challenging and exciting pioneering effort.

The first step is to characterize the learners in terms that will affect the way the course will be taught (Step 1, Fig. 2). For example, some learners may have already had experience in the particular field in which they will be studying. If the percentage of such learners changes with the time of year this will also be included in the analysis.

The second step, we believe, is to state general policy (Step 2, Fig. 2). *Policy*, as used here, means such things as the nature of the objectives of the institution. Many institutions have input-oriented objectives; some have output-oriented objectives. An input-oriented institution might be, for example, a labor union which requires that every union member have taken a certain number of weeks of a specific kind of vocational course. Most military and industrial training, however, is output-oriented. Industry and the military want a man who has particular skills and knowledge; if the amount of input required to get that same output can be reduced, so much the better.

General policy also requires a statement of whether the school wants a standard or a diverse output. If the learners are fairly homogeneous, this question is not very important, but if they are hecerogeneous, it is. (The Air Training Command tries to produce standard graduates in the technical center, although no one really believes that all airmen are exactly the same when they have finished a technical course.) Another aspect of general policy has to do with the way in which the school relates to those institutions that use its graduates and those that supply its students.

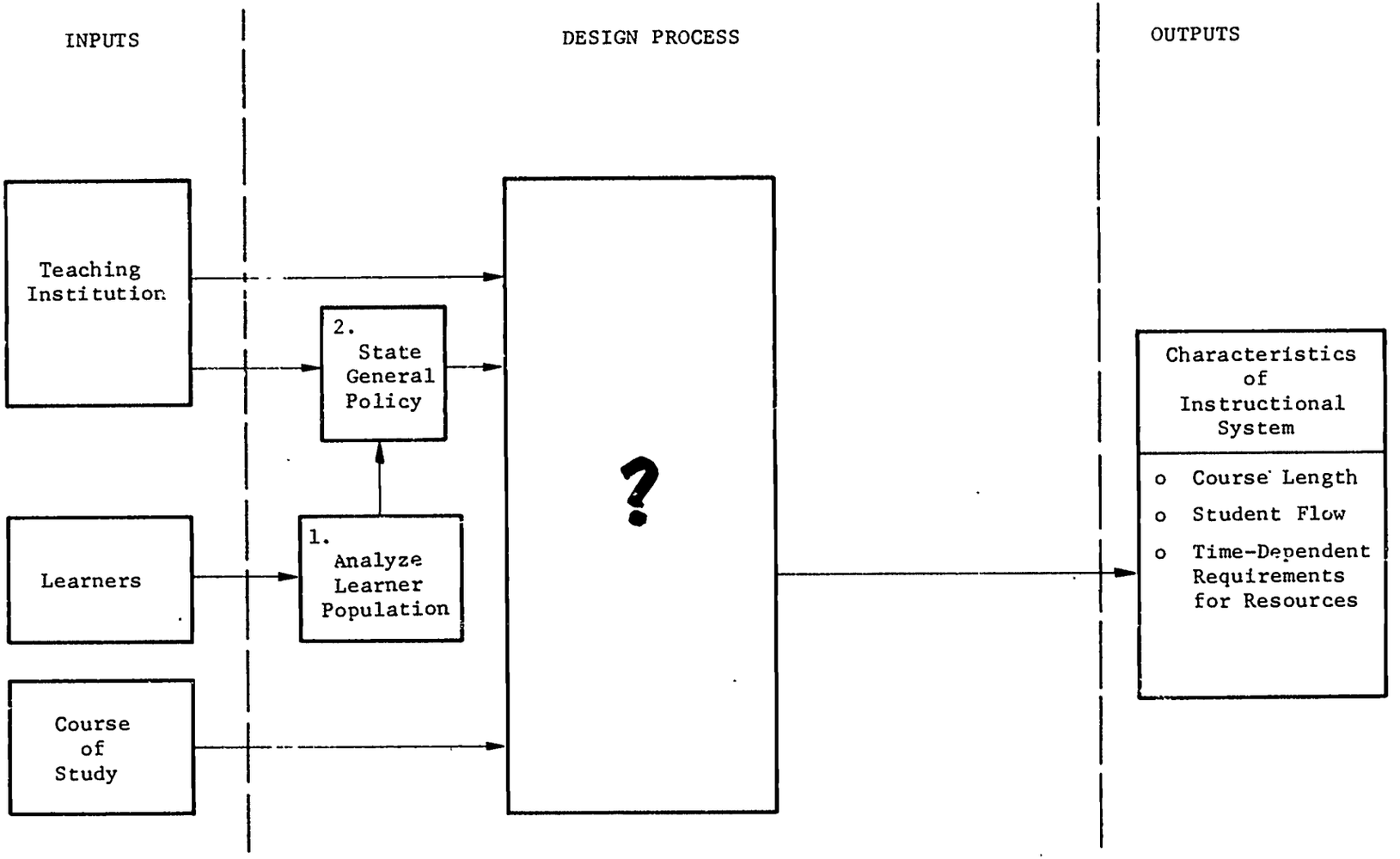

Fig. 2--First Steps in the Preliminary Analysis

The third step, the Lesson Analysis, is denoted Step 3(a) (Fig. 3) because it is interrelated with the next step. This analysis is a branching questionnaire that guides the user in providing a detailed description of the course of study. First, it typifies each lesson in "system-oriented" terms such as whether the instruction must be given in a classroom or in a laboratory, whether it requires special equipment, or whether it requires a monitor to ensure student safety. For example, if the students are learning how to take good pictures, the instruction would require special equipment, namely, a camera. If the students are learning only how a camera operates, the instruction might take place entirely in a classroom with only visual aids to show how the camera operates.

The Lesson Analysis also characterizes each lesson's requirements for communication media. We have focused on communication media because a communication medium can carry the burden of classroom instruction and therefore can provide alternatives to teachers under expectedly heavy student loads or in cases where high-quality teachers are scarce. The selection of appropriate communication media for instruction is an extremely difficult process; we believe that we can provide systematic guidance in this area.* However, the design methodology does *not* specify that communication media must be used for every lesson even though the Lesson Analysis describes possible requirements for communication media. Another process allows the *user* to specify whether or not he will use media. This process is a logic tree that assists the user in specification of strategies of instruction, Step 3(b), which interacts closely with the Lesson Analysis. (See Fig. 3.) At the same time, the framework for this specification is provided by the statement of general policy as well as by indirect input from the teaching institution.

As used here, a strategy of instruction has two dimensions. For each type of instruction identified in the Lesson Analysis it specifies: (1) whether a person or medium will be teaching, and (2) how students will interact with this teaching. Answers to these two questions specify

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*Rudy Bretz, *The Selection of Appropriate Communication Media for Instruction: A Guide for Designers of Air Force Technical Training Programs*, The Rand Corporation, R-601-PR, February 1971.

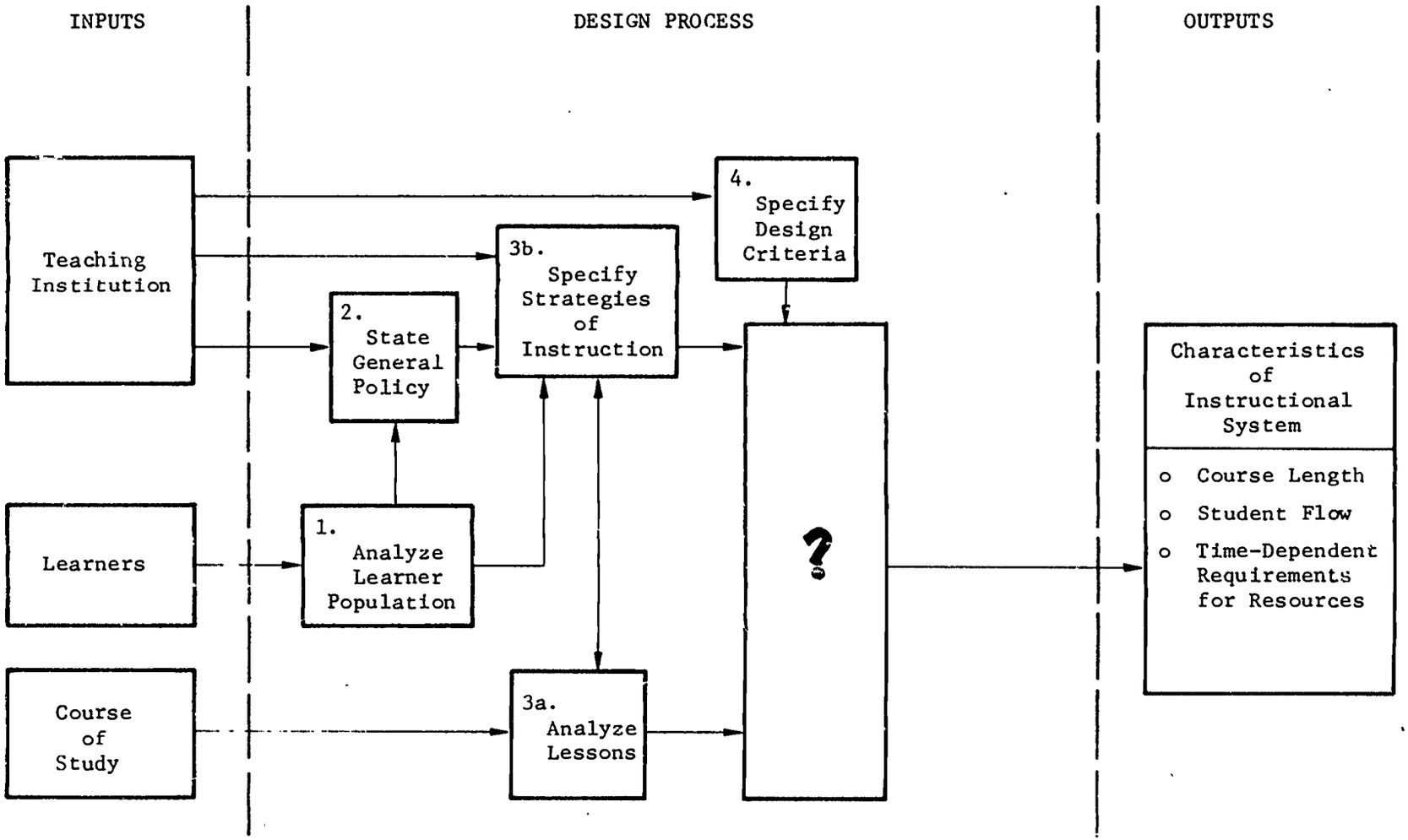

Fig. 3--Preliminary Analyses: Setting the Stage

a teaching method. The strategy also permits specification of details of the use of media or people for each type of instruction such as the level of skill the people should have. The user is assisted in finding his way through the logic tree by a time-shared computer program accompanied by a manual that presents the pros and cons of the decisions to be made at each point.

Step 4, Fig. 3, establishes a set of design criteria, input from the teaching institution. They will be of the following sorts: least cost, shortest course length, graduation of the most students per unit time, or maximum use of communication media. The user would assign each criterion an order of importance or a weight.

Once the criteria have been specified, the actual system design can begin (Step 5, Fig. 4). The direct inputs to the design will be the strategies of instruction, the Lesson Analysis, and the design criteria. Characteristics of the learner population, the stated general policy, and the general features of the course of study also enter into the design process indirectly.

At present, we see the design process as having four main components: First, each learning event is linked to the strategy of instruction that has been chosen for that particular type of event. Second student flow through the course is simulated by a flow and scheduling model. Third, a set of criteria is used to select specific media systems. (The Lesson Analysis only identifies the class of media (for example, motion-visual) that might be used for a particular lesson. What precise form the media system should take (for example, silent film) will be specified by the strategies of instruction and other criteria which are being developed.) Fourth, a set of criteria is used to assign personnel. Although there will be instances where a certain number of people will be required to carry out a particular task, such as monitoring for safety, other personnel requirements will be harder to identify--such as determining the number of students that can feasibly be assigned to a teacher in a classroom. This component still has to be worked out. The final step will be a cost analysis to determine the time-dependent dollar requirements for the system.

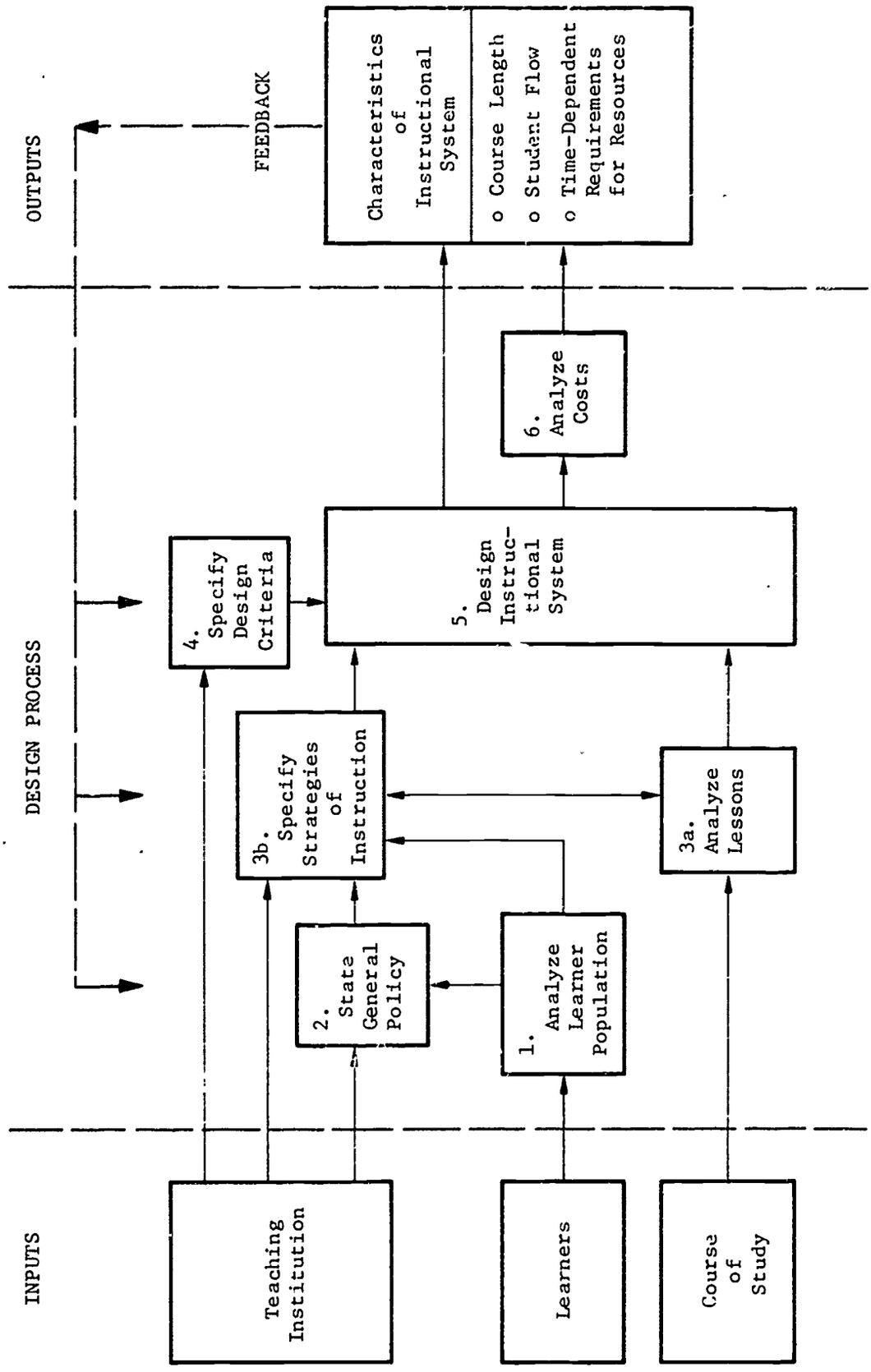

Fig. 4--The Design Process as a System of Interrelated Elements

As noted above, the outputs of the design process will be: course length, student flow, and time-dependent requirements for resources; all are useful for the planner. He can then compare the requirements for resources with resources he expects to be available to the school to determine whether the system is economically feasible; he can also compare the outputs with requirements for general policy and other inputs to determine whether they satisfy what he wanted. If not, he can change some of the initial specifications such as the strategies of instruction or the design criteria. Possibly he would want to change the learner population, the course of study, or even the general policy.

Although these tools compose a closely interrelated set of elements in system design, several are useful in their own right. For example, the decision process for setting instructional strategy contains a comprehensive check list of considerations in instructional system design that can be used without the computer program if so desired. Similarly, the Lesson Analysis helps the user look at his subject matter in a methodical and systematic manner. The work has been directed toward very general applications so that it will be of use not only to Air Force organizations such as the Air Training Command and the Air Force Academy but to educational institutions in the public sector as well.